A SUPERPOSITION FRAMEWORK FOR DISCRETE DISLOCATION PLASTICITY

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A superposition technique is introduced which allows for the application of discrete dislocation (DD) plasticity to a wide range of thermo-mechanical problems with reduced computational effort. Problems involving regions of differing elastic and/or plastic behavior are solved by superposing the solutions to (i) DD models only for those regions of the structure where dislocation phenomena are permitted, subject either zero traction or displacement at every point on the boundary, and (ii) an elastic (EL) (or elastic/cohesive-zone) model of the entire structure, subject to all desired loading and boundary conditions. The DD sub-problem is solved with standard DD machinery for an elastically homogeneous material. The EL sub-problem requires only a standard elastic or elastic/cohesive-zone FE calculation. The sub-problems are coupled: the negative of the tractions developed at the boundaries of the DD sub-problem are applied as body forces in the EL sub-problem, while the stress field of the elastic sub problem contributes a driving force to the dislocations in the DD sub-problem structure. This decomposition and the generic boundary conditions of the DD sub-problem permit the DD machinery to be easily applied as a "black-box" constitutive material description in an otherwise elastic FE formulation and to be used in a broader scope of applications due to the overall enhanced computational efficiency. The method is validated against prior results for crack growth along a plastic/rigid bimaterial interface are presented.